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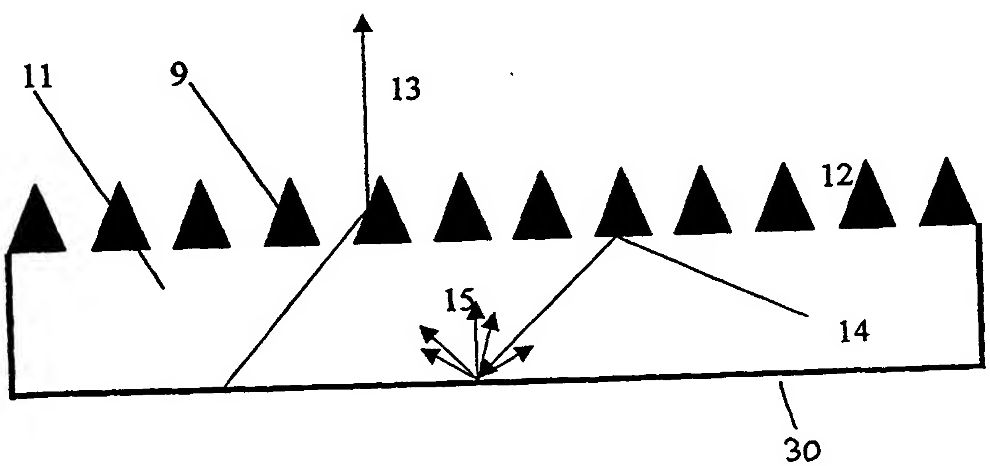
(54) Title: RADIATION SOURCE PRODUCING A COLLIMATED BEAM



(57) Abstract: This invention concerns the production of a large-area collimated beam of radiation for use in displays. A highly reflective diffusely illuminated cavity source (11) has apertures (12) which allow the selected radiation to pass through directly over a first range of angles. Each aperture (12) has a finite depth and angled sides tapering outwardly so that the radiation which enters the aperture at a second, larger range of angles impinges on the walls (6) of the aperture and is redirected into a preferred direction by reflection at the walls of the aperture. Any radiation not entering an aperture is reflected inside the reflective cavity from the wall which has low absorption and is diffusely reflected from another cavity wall (30), so that it has a finite probability of entering any one of the array of apertures. In this way the light that has not entered an aperture will be randomly reflected back to try again.

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RADIATION SOURCE PRODUCING A COLLIMATED BEAM

The invention is concerned with the production of a two-dimensional well-defined collimated beam of light or beam of light of restricted angular distribution. Such a source is useful in particular for liquid-crystal displays and other modulator devices, partly because the opto-electronic properties of the liquid crystal are sensitive to the direction of incident light and partly for simple geometric reasons of avoiding crosstalk in pixellated displays in which the liquid-crystal switching layer is separated from the red, green and blue layer by a finite distance.

In principle collimated light can be produced by expanding light from a point source such as a pinhole, or a set of point sources, using a lens or a corresponding array of lenses, or simply by stopping down a diffuse source. However, this inevitably discards a large proportion of the light generated.

EP-A1-30875 (Commissariat à l'Energie Atomique) describes light sources for liquid-crystal displays, including in Fig. 4 one in which light from an array of tubes passes through an array of pyramidal apertures aligned with those tubes and then a corresponding array of collimating lenses. However, this is essentially a more sophisticated version of the pinhole concept and uses only a small proportion of the available light.

The invention provides a radiation source comprising a wall defining a cavity for enclosing a radiation generator, and a set of apertures in the wall, in which the apertures taper through the thickness of the wall, forming channels that increase in cross-sectional area from the interior to the exterior of the cavity, while the wall efficiently reflects light missing the apertures so that it travels through them in a subsequent pass.

This construction means that, with the sides of the apertures being suitably reflecting, light entering the apertures at highly oblique angles will strike the sloping sides and be reflected substantially towards the normal, forming a substantially collimated beam.

The collimated beam is formed from an array of localised three-dimensional channels which are positioned after the radiation generator, which can be a large-area diffuse source. The cavity wall can enclose the radiation generator completely, using a low-loss reflective inner surface except where the apertures occur. The channels are not simple holes, but instead have a finite depth as in the case of a tunnel. The channels are defined by two openings, which are called the input orifice and the output orifice. The input orifices are those orifices closer to the light source. The output orifices are the orifices further from the source; that is, radiation must pass through the input orifice in order to arrive at the output orifice. Because of the taper, passage through any one of the apertures results in radiation that impinges on the sides of the channel being re-directed towards the axis by reflection in such a way that the new path of the radiation makes a smaller angle with the axis. The axis of the channel is defined as the line passing through the midpoint of both orifices. Of course, light passing straight through the channel is reasonably well collimated in any event, provided that the depth of the aperture is comparable with its diameter.

The fact that the input orifice has smaller dimensions than the output orifice results in a tapered structure inside the channel, with the sides angled away from one and other so that the sides of the channel totally enclose the channel between the orifices. Embodiments of the invention can have

different forms for the illumination of a display device. The form of the device is dependent upon the requirements of the particular display. Varying the angle the side of the channel makes with the axis of the channel, hereafter called the taper angle changes the amount by which the radiation passing through the channel has the angle it makes with the axis of the channel changed by reflection by a different degree, if it has originally an angle greater than the taper angle.

The range of useful taper angles can be divided into two regimes. In the first, a highly collimated output is required. For this to be achieved the maximum angle of radiation which can traverse the channel must be directed so as to be collected by an optical element which further concentrates the intensity into a restricted angular distribution. This requires a taper angle between about 15° and 40°. For radiation concentration in a system where collimation is not required but there is a preferred angular distribution, taper angles of between 40° and 65° can be used. An example of this would be for use in the backlight of a conventional transmissive LC display. Normally this range of angles does not require additional optical elements.

For a better understanding of the invention embodiments of it will now be described, by way of example, with reference to the accompanying drawings, in which:

Figs. 1 and 2 show the geometrical background;

Fig. 3 shows a single aperture which can be used in embodiments of the invention;

Fig. 4 shows an array of such apertures, in section;

Fig. 5 shows an embodiment similar to Fig. 4 but with an additional optical element; and

Fig. 6 shows a variant of the Fig. 5 embodiment, with a different optical element.

Figure 1 shows the definition of the coordinate system that may be referred to in describing aspects of the invention. An aperture 1 is shown in a flat surface of relatively large area 2 hereafter referred to as the output plane although of finite thickness along the axis z in the coordinate system shown. The normal to the output plane is along the z direction. The axis of the aperture 3 is usually, but not necessarily, parallel to the normal to the output plane, depending on the required form of the illumination. The aperture is in a wall of a cavity source which may contain a radiation source or may be injected with electromagnetic radiation to be used in a display device. The radiation may be visible or of the ultra-violet part of the electromagnetic spectrum. In the case of visible light the images are made up of this light. In the case of the ultra-violet light the images on the screen can then be made up from the excitation of emissive materials such as phosphors, that emit in the visible part of the spectrum. The electromagnetic radiation may in this case be essentially monochromatic, while in the former case it will have a spectral range.

Figure 2 shows the effect of reflection from an inclined surface 6 on the direction of a ray of light. The taper angle is defined as the angle 7 the reflecting surface makes with the desired direction of collimation, in this case the z-direction. The angle the incident ray makes with this direction 5 is changed to a smaller angle 8 after reflection. For clarity the angles will be given symbols as follows: angle 7 $\equiv \theta_t$, angle 5 $\equiv \theta_i$ and angle 8 $\equiv \theta_o$. It can be shown with simple geometry that the following relation holds for the angle the ray makes with the z-direction in the

plane defined by the z-direction and the direction of the ray:

$$\theta_o = | 2\theta_t - \theta_i |$$

That is to say, the output angle with respect to the collimation direction (z) is equal to the absolute value of twice the taper angle minus the angle of the ray with respect to the z-direction before reflection. As an example, a ray incident at 90° with respect to the z-direction being incident on a reflecting surface inclined at 45° to the z-direction will be reflected so that it makes an angle of 0° with respect to the z-direction. This is only true in the plane defined by the z-direction and the incident beam, i.e. the plane containing them.

The response of the taper in terms of the angular distribution output from the output orifice is a scalable characteristic of two parameters. The first is the taper angle which is defined in Figure 2 as the angle with respect to the axis of the system made by the sloping walls of the tapered pinholes. The second is the ratio of the area of the input orifice to that of the output orifice, hereafter called the fractional area. The dimensions of the tapered pinhole are defined by the taper angle, the fractional area and the height or distance from the internal orifice to the external orifice. The optical elements must be tailored for each dimension, however. In terms of manufacturing, this height is responsible for determining the manufacturing process used to make a mould for injection moulding.

For example, if the structure is made to be very small (millimetres) then a reverse mould, consisting of solid pyramidal tips from which the tapered holes can be moulded, can be formed by diamond tip cutting so as

to leave a specularly reflecting surface. In this case an array of pyramidal structures can be formed together by cutting in straight lines across the array area in orthogonal directions.

As another example, if the structure is made of dimensions (centimetres) such that the use of diamond tip cutting is not advantageous then individual pins (e.g. square pins in the simplest case) can be ground so that their ends form the reverse pyramidal shape. These ends can then be polished until they have optically smooth surfaces. The pins are then assembled into an array which forms the reverse master for the array of tapered pinholes.

In both instances the actual array of tapered pinholes can be formed by injection moulding, for example.

Figure 3 shows an example of a possible shape for an individual tapered aperture. This will be referred to as a tapered pinhole. In this case both orifices, internal and external, of the pinhole are square, but this need not be the case. Also the taper is linear here, but it need not be so. Any two-dimensional shape can be used to define the input and output orifices; the design may be a function of the angular distribution required or a manufacturing consideration. The area of the external orifice 10 is greater than that of the internal orifice 9. Four specularly reflective sides 6, which need not be inclined by the same amount, form the tapered pinhole. In the diagram they are shown as equivalent, for simplicity. Most of the beams entering the input orifice 9 at an angle with respect to the tapered pinhole axis 3 greater than the taper angle will undergo reflection at the side and be re-directed towards the axis 3. Note that some rays will impinge upon more than one face in the tapered aperture. This results in more than one reflection

towards the axis of the aperture. In the case of the square tapered aperture the changes in the angular extent due to reflection off adjacent walls results in an improvement in the collimation angle in two orthogonal directions.

Figure 4 shows a cavity backlight 11 with tapered holes 12 as an illustration of the two possibilities for a ray travelling significantly off-axis towards the front wall of the cavity, i.e. the output plane Z (though it need not be planar). In one case the ray is reflected from the side of the taper and has its angle changed accordingly, as at 13. In the other case the ray does not enter an aperture 14 but is reflected from the solid part of the front wall and then diffusely reflected 15 from a rear plate 30; the diffuse nature of the reflection is illustrated by a random selection of the possible paths the ray will take. The ray will now arrive at the output plane Z a second time and has a finite probability of entering an aperture. The fraction of light that will escape through the tapered pinholes is a function of the size or area of the input orifices 9 and the reflectivity of the interior of the cavity. As can be seen in Figure 4, the backlight is a closed shallow box forming the cavity, the rear plate 30 and the sidewalls being made of or coated with a continuous, highly reflective material, and likewise the front wall, apart of course from the openings.

Figure 5 shows how an additional optical element 17 can improve the collimation of the output from the tapered pinholes by refraction or diffraction. Rays output from the tapered pinholes can be further re-directed 16 using refractive lenses or diffractive holograms/structures, which can be incorporated in a transparent plate forming the optical element 17.

An example of a suitable optical element is a simple plano-convex lens (i.e. one of an array of

lenses) which is situated after a tapered pinhole. The curvature of the lens would be such that those rays which make the highest angle with the z-axis at the output orifice are re-directed towards the z-axis by the action of the refraction at the interface between the convex surface of the lens and air. Those rays which are already highly collimated when they reach the lens surface must not be deviated from their path to such an extent that they leave the lens surface at an angle with respect to the z-axis that is not within the desired angular distribution.

The nature of the optical element will vary for different dimensions of tapered pinhole. An illustration of this is as follows: if a plano-convex lens with second radius of curvature of x millimetres is suitable for use with a tapered pinhole of output aperture of y^2 mm^2, then this does not mean that the same lens design would be suitable for a tapered pinhole of $(2y)^2$ mm^2. A very obvious example is given if the new taper output orifice dimension is such that the lens radius of curvature is such that the lens does not span the orifice. In any event it should be noted that non-circular apertures cannot be perfectly covered by lenses.

In order to maximise the radiation-collecting ability of the lens system it is possible to have a bi-convex lens which is made from two convex surfaces which share the same substrate but on opposing sides of the substrate. In this case one of the surfaces can be allowed to curve into the tapered aperture at the output orifice. This allows a more varied optimisation of the lens than the simple plano-convex case.

Figure 6 shows the use of a different optical element, namely a dielectric stack 18. Here a ray 20 with an angle not within an acceptable angular range with respect to the angle it makes with the z-direction

can be selectively reflected 19 using the dielectric interference stack 18. Such a stack works best with a radiation source with a restricted range of wavelengths, which makes it possible to achieve the interference conditions for a range of angles. If the angular distribution required of the rays with respect to the z-direction is that all rays make an angle which is less than θ_c then the rays which are not within this distribution can be selectively reflected and recycled after passing back into the cavity, as shown at 21.

Recycling inside the cavity is a function of the reflectivity of the walls of the cavity, the fraction of the total area constituted by the apertures, or rather by the inlet orifices, the total area of the wall of the cavity that has no apertures and the flux of radiation inside the cavity. The ratio of the total flux inside the cavity to that which exits via the apertures can be shown to be approximately:

$$\frac{\Phi_o}{\Phi_T} = \frac{na_n \times \rho_r}{1 - \rho_r(1 - na_n)}$$

where

Φ_o = the flux escaping the cavity,

Φ_T = the total flux in the cavity,

n = the number of apertures,

a_n = the normalised area of each aperture, and

ρ_r = the reflectivity of the cavity walls.

The efficiency of the system can be maximised once the required angular distribution has been chosen. In all cases as high a reflectivity for the cavity walls as is possible is required. It should be noted that increasing the number of lamps or other radiation sources within the cavity itself decreases efficiency, since the material of the lamps may absorb the light emitted by itself or other lamps. The above equation

assumes that there is no loss mechanism associated with the radiation impinging on the surfaces of any radiation sources within the cavity after reflection from the cavity walls.

It should be noted that because of the highly reflecting surfaces of the cavity in this system it is unnecessary to line the lamps up with the apertures. A single lamp can be used, or a row of lamps less in number than the number of columns of apertures (assuming they are laid out regularly); in any event he lamps should not obscure the apertures. Alternatively a diffusely emitting rear plate can be used.

The cavity wall or walls can be made by a moulding process. For instance, the wall containing the apertures can be injection-moulded in a plastics material and the aperture walls rendered specularly reflective, e.g. by metal coating, while the interior surface is made diffusely reflective, or specularly reflective with a diffusing element within the cavity, e.g. the radiation sources, or a combination of specularly and diffusely reflective. The walls should have reflectivity of at least 95%, preferably at least 97%, over the relevant wavelength range. Material such a barium sulphate can reflect 99% of incident light.

In summary, in the examples of the invention as described a cavity source of diffuse radiation has at least one aperture, but preferably more, in a wall of finite thickness, called the output plane. The apertures are distributed over the plane. The purpose of the apertures is to direct the radiation in a preferred direction. They can do this in conjunction with another optical element. However, the apertures themselves direct the radiation towards a chosen direction by reflection. To this end, the sides of the apertures are not parallel to this direction but are at an angle to it. That is to say, the holes in the

output plane are tapered in that the radiation enters into an aperture which becomes increasingly large as the thickness of the output plane is traversed. The radiation that is not incident on an aperture is diffusely reflected inside the cavity in such a way that there it is a possibility that it will subsequently enter one of the apertures. This selection and reflection process will determine the efficiency of the radiation output from the system with respect to that put into it or generated inside the cavity.

After each tapered aperture there may exist a refractive optic such as a lens that collects the radiation from the tapered pinhole and further re-directs it into an angular distribution that is more restricted than that from the tapered pinhole alone. Alternatively, an optic can be placed after the output apertures that selects an angular range for reflection and another for transmission. Radiation that is reflected is sent back into the cavity and is recycled.

Alternatively, or in addition, an optic can be placed before the apertures, i.e. on the side of the output wall which faces the radiation sources, that angularly selects the radiation arriving at the input orifice and only allows to pass those rays which will be collimated to an acceptable degree after passing through the apertures. An example of such an optic would be a dielectric interference stack of layers, as described for instance in WO 98/49585.

Furthermore the cavity walls could be made selectively reflective so that they preferentially reflect certain wavelength ranges emitted by the radiation source. This could be advantageous where, say, the radiation is to be substantially monochromatic. An example would be the suppression of the green light inherent in all mercury-discharge

lamps, maintaining the near-UV radiation substantially undiminished.

The tapered apertures, and indeed the cavity itself, are shown in the embodiments as being empty, i.e. filled with air or other gas. However, they could be filled with a solid or liquid material of suitable optical properties.

The collimator was conceived for use with visible or UV light and in particular with displays, but it could in principle be used for other electromagnetic wavelengths or even for other radiation, such as ultrasound.

Claims:

1. A radiation source comprising a wall defining a reflective cavity (11) for enclosing a radiation generator, or the radiation emitted by such a generator, and a set of apertures (12) in the wall, in which the apertures taper through the thickness of the wall, forming channels that increase in area from the interior to the exterior of the cavity, the inner surface of the wall being such that light exits from the cavity only over a restricted range of angles through the apertures, while a substantial proportion of the remaining light is reflected from the wall so as to be recycled within the system, thereby to allow further passes through the apertures, increasing the efficiency of the radiation source.

2. A source according to claim 1 and containing at least one narrow-band light generator, wherein the radiation generated has a FWHM of about 15μ in the blue or near-UV wavelength region.

3. A source according to claim 1 or 2, in which the inner walls of the cavity preferentially reflect light of predetermined wavelengths and absorb unwanted wavelengths.

4. A source according to claims 2 and 3, in which the said predetermined wavelengths correspond to the said narrow band of the radiation.

5. A source according to any preceding claim and having a plurality of light generators distributed throughout the cavity substantially without blocking the path of reflected light to the apertures.

6. A source according to any of claims 1 to 4, in which the generator is formed by or includes part of

the cavity wall itself.

7. A source according to any preceding claim, in which the cross-section of the apertures is of uniform shape along their depth.

8. A source according to claim 7, in which the aperture section is square or rectangular.

9. A source according to any preceding claim, in which the walls taper uniformly at between 15° and 65°.

10. A source according to any preceding claim and further including an optical element which further re-directs the radiation in a preferred direction by refraction or diffraction.

11. A source according to claim 10, in which the optical element (17, 18) is located on the outside of the cavity wall.

12. A source according to claim 10 or 11, in which the optical element is continuous over the wall area containing the apertures.

13. A source according to claim 12, in which the optical element is a dielectric stack (18) which uses constructive and destructive interference for a limited range of wavelengths to select the radiation that is transmitted and that which is reflected.

14. A liquid-crystal display using a light source as claimed in any preceding claim.

15. A liquid crystal display according to claims 2 and 14, in which the display has phosphor-type output elements activated by the said narrow-band light.

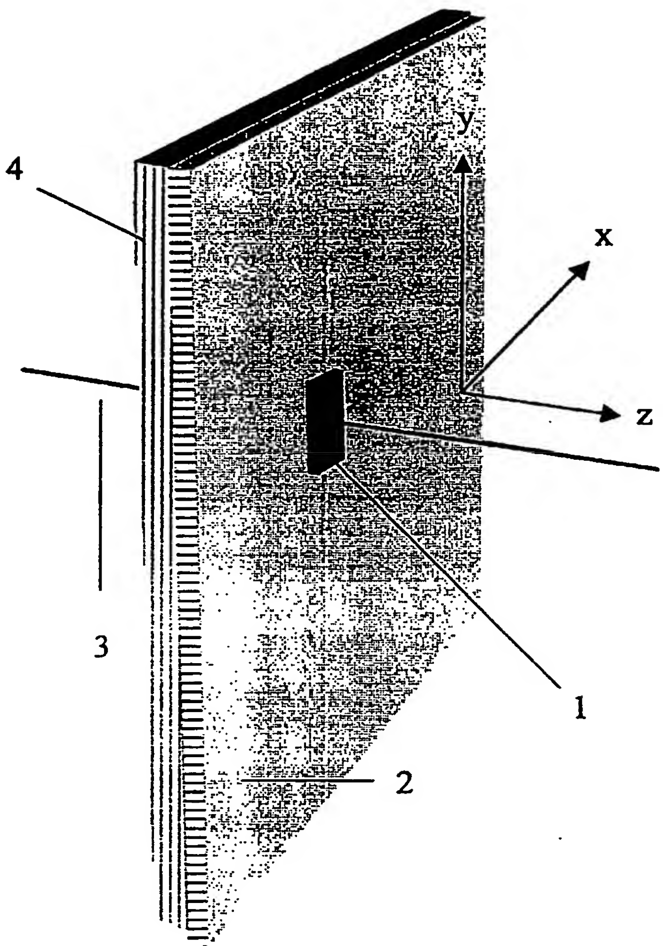

Figure 1

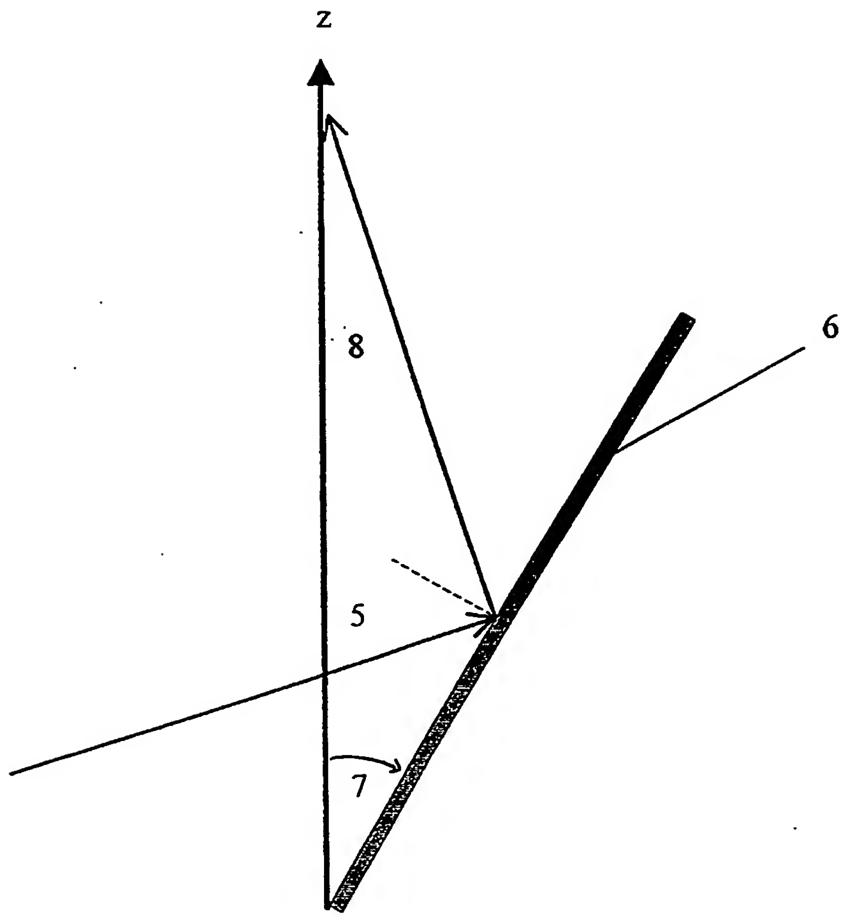

Figure 2

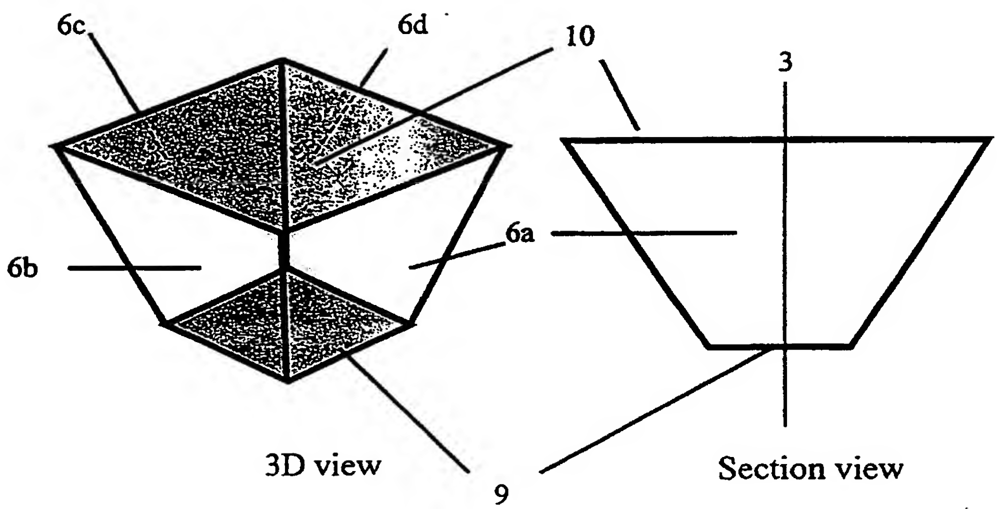

Figure 3

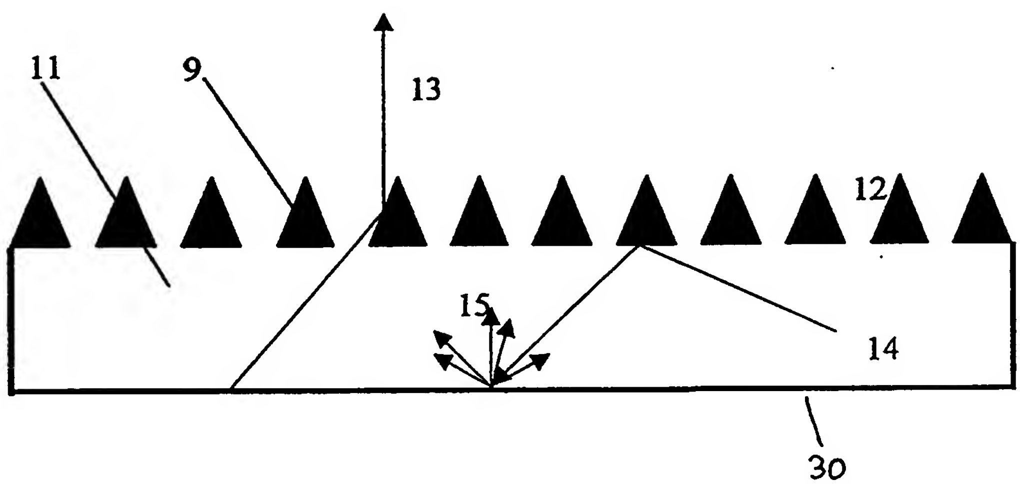

Figure 4

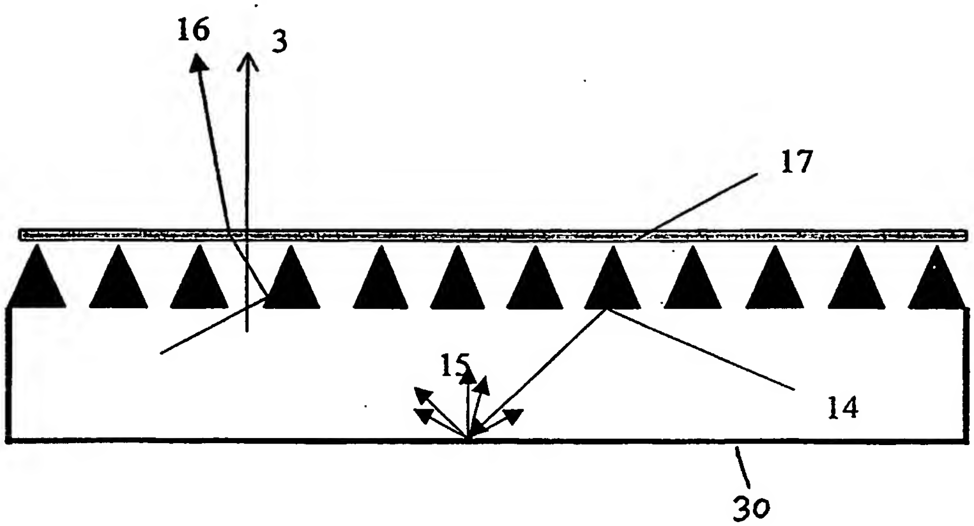

Figure 5

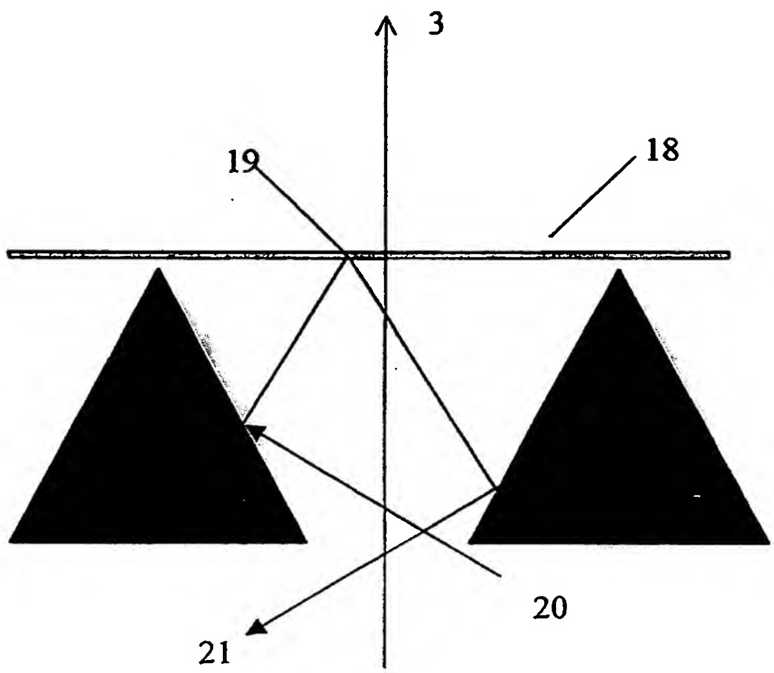

Figure 6

INTERNATIONAL SEARCH REPORT

Inten   l Application No
PCT/GB 01/00179

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F21V8/00 G02F1/13357

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F21V G02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 839 812 A (GE XIAOQIN ET AL) 24 November 1998 (1998-11-24) column 3, line 66 - line 67 column 4 -column 5 column 6, line 1 - line 53 figures 1-15	1,5-12, 14
X	US 3 676 667 A (MALIFAUD PIERRE) 11 July 1972 (1972-07-11) figures 1,5-7,11,12	1,5,7,8, 10-12
A	US 4 330 813 A (DEUTSCH JEAN-CLAUDE) 18 May 1982 (1982-05-18) cited in the application figure 4	1

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
28 March 2001	11/04/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Ward, S

INTERNATIONAL SEARCH REPORT

Intern d Application No
PCT/GB 01/00179

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 735 495 A (HENKES JOHN L) 5 April 1988 (1988-04-05) figures ---	1,5,7,10
A	WO 98 49585 A (CROSSLAND WILLIAM ALDEN ;DAVEY ANTHONY BERNARD (GB); SCREEN TECH L) 5 November 1998 (1998-11-05) cited in the application page 11, line 25 - line 36 page 12, line 1 - line 17 ---	1,2, 10-15
A	US 4 814 956 A (KANO TETSUHIRO) 21 March 1989 (1989-03-21) column 3, line 3 - line 19 figures 1-3 ---	1,3,4
A	US 5 428 468 A (ZIMMERMAN SCOTT M ET AL) 27 June 1995 (1995-06-27) abstract; figures 4,4A ---	1
A	EP 0 814 300 A (CASIO COMPUTER CO LTD) 29 December 1997 (1997-12-29) abstract; figures ---	1
A	US 5 810 469 A (WEINREICH STEVE) 22 September 1998 (1998-09-22) abstract; figures -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 01/00179

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 5839812	A	24-11-1998	NONE			
US 3676667	A	11-07-1972	AT	321612	B	10-04-1975
			BE	736085	A	16-12-1969
			CH	502604	A	31-01-1971
			DE	1936715	A	02-07-1970
			ES	369598	A	01-06-1971
			FR	1602203	A	26-10-1970
			GB	1284123	A	02-08-1972
			NL	6911068	A	21-01-1970
			SE	364120	B	11-02-1974
US 4330813	A	18-05-1982	FR	2471012	A	12-06-1981
			CA	1173180	A	21-08-1984
			DE	3068970	D	20-09-1984
			EP	0030875	A	24-06-1981
			ES	498266	D	01-04-1982
			ES	8203523	A	01-07-1982
			JP	1499531	C	29-05-1989
			JP	56092580	A	27-07-1981
			JP	63046428	B	14-09-1988
US 4735495	A	05-04-1988	NONE			
WO 9849585	A	05-11-1998	AU	7069198	A	24-11-1998
			CN	1261439	T	26-07-2000
			EP	0978004	A	09-02-2000
			US	6078421	A	20-06-2000
US 4814956	A	21-03-1989	DE	3515879	C	11-12-1986
			JP	1713691	C	27-11-1992
			JP	3075964	B	04-12-1991
			JP	61263002	A	21-11-1986
US 5428468	A	27-06-1995	US	5396350	A	07-03-1995
			AU	2280295	A	05-12-1995
			CA	2190122	A	23-11-1995
			CN	1148428	A	23-04-1997
			DE	69507456	D	04-03-1999
			DE	69507456	T	15-07-1999
			EP	0749550	A	27-12-1996
			JP	10500528	T	13-01-1998
			WO	9531672	A	23-11-1995
			US	5521725	A	28-05-1996
			US	5555329	A	10-09-1996
			US	5555109	A	10-09-1996
			US	5739931	A	14-04-1998
			US	5761355	A	02-06-1998
			US	5748828	A	05-05-1998
			US	6129439	A	10-10-2000
			AT	180322	T	15-06-1999
			AU	1087795	A	23-05-1995
			CA	2174528	A	11-05-1995
			CN	1136349	A	20-11-1996
			DE	69418617	D	24-06-1999
			DE	69418617	T	03-02-2000
			DK	727028	T	08-11-1999
			EP	0727028	A	21-08-1996

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern al Application No

PCT/GB 01/00179

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5428468 A		ES 2132597 T	16-08-1999
		FI 961880 A	03-05-1996
		GR 3030897 T	30-11-1999
		JP 2706574 B	28-01-1998
		JP 8511129 T	19-11-1996
		SG 47942 A	17-04-1998
		WO 9512782 A	11-05-1995
EP 0814300 A	29-12-1997	JP 10012024 A	16-01-1998
		JP 10012025 A	16-01-1998
		JP 10289604 A	27-10-1998
		JP 10289605 A	27-10-1998
		KR 237405 B	15-01-2000
		US 5914760 A	22-06-1999
US 5810469 A	22-09-1998	AU 6524494 A	24-10-1994
		WO 9423330 A	13-10-1994